

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

REMARKS/ARGUMENTS

Examiner Kripa Sagar is thanked for thoroughly reviewing the subject application.

Independent claims 1, 20, 23, 26, 35, 44 and 53 of the claimed invention have been amended. The matter that has been used for these amendments has been copied from the original specification, no new matter has been introduced.

Favorable reconsideration of this application in light of the above amendments and the following remarks is respectfully requested. All claims are believed to be in condition for allowance.

Double Patenting

Reconsideration of the rejection based on Double Patenting is respectfully requested based on the following.

A terminal disclaimer is attached, which is believed to overcome the double patenting rejection.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection based on Double Patenting be withdrawn.

Claim Rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claim 1 under 35 U.S.C. 102(e) as being anticipated by Peng (U.S. Patent 6,514,648) is respectfully requested based on the following.

Peng provides a method to produce equal sized features in microlithography.

More specifically, Peng provides for:

- an exposure mask that contains a first region, which exposes a first portion of a to be created image
- the same exposure mask (see col. 3, lines 48 e.a., contains compensating regions in the vicinity of the first region, which partially expose the first region in addition to exposing a second region; the second region is to be removed from the substrate.

More specifically yet, Peng provides for, using Figs. 2a-2c of Peng as illustrative examples:

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

- the features 9 and 11, with feature 11 having adjacent features 13/15, are the desired features; feature 11 is a nested feature located between features 13 and 15, feature 9 is an isolated feature; the objective is to provide features 9 and 11 such that equal width $W_i = W_n$ is achieved
- to obtain the above stated objective, adjacent compensating features 13/15 and 17/19 are provided over the exposure mask which is used to also expose features 9 and 11 with its adjacent features 17/19
- compensating features 13/15 are removed by, col. 5, lines 63 e.a., "only features 13 and 15 may be exposed"; that is the mask used for the removal of the compensating features contains an image of the compensating features 13/15 only
- compensating features in the exposure mask which contains the desired features can be provided, see col. 6, lines 1 e.a., in a number of different configurations, thereby including a variation of the number of compensating features that can be provided in the original exposure mask; all such compensating features are removed using a second exposure mask which contains an image of these compensating features
- the shape of the compensating features may additionally be varied, such as for instance shown in Fig. 2b, elements 13 and 15.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

In sum, and as further highlighted in Figs. 3a-4b of Peng, Peng creates images using a first exposure mask, including therein compensating images, then removes the compensating images using a second exposure mask.

What therefore is not provided by the Peng invention, in marked contrast with the claimed invention, making the claimed invention patentable over the Peng invention, can best be illustrate by quoting amended claim 1 of the claimed invention, which specifies the method of the claimed invention of creating closely spaced contact holes, and by underlining in the quote the unique aspects of the claimed invention where these aspects are compared with the Peng invention, as follows:

(1) providing a substrate, the substrate having been provided with a first layer of material for creation of a pattern of contact holes;

(2) exposing the first layer of material with a first mask, the first mask comprising a first and a second pattern of contact holes having a first and second critical dimension, the first and second pattern being interspersed;

(3) creating openings in the first layer of material in accordance with the first and second pattern of contact holes;

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

(4) depositing a second layer of material over the first layer of material, including the openings created in the first layer of material in accordance with the first and second pattern of holes;

(5) exposing the second layer of material with a mask selected from the group consisting of:

(i) a second mask comprising a third pattern of holes having a third critical dimension, the third pattern of holes being aligned with the second pattern of holes, the third pattern of holes being a transparent pattern of holes with a surrounding opaque background surface, the third critical dimension comprising a range of critical dimensions being equal to or larger than said second critical dimension;

(ii) a third mask comprising a third pattern of holes having a third critical dimension, the third pattern of holes being aligned with the second pattern of holes, the third pattern of holes being an opaque pattern of holes with a surrounding transparent background surface, the third critical dimension comprising a range of critical dimensions being equal to or larger than the second critical dimension;

(iii) a fourth mask comprising a fourth pattern of holes having a fourth critical dimension, the fourth pattern of holes being aligned with the first pattern of holes, the fourth

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

pattern of holes being a transparent pattern of holes with a surrounding opaque background surface, the fourth critical dimension comprising a range of critical dimensions being equal to or larger than the first critical dimension;

(iv) a fifth mask comprising a fourth pattern of holes having a fourth critical dimension, the fourth pattern of holes being aligned with the first pattern of holes, the fourth pattern of holes being an opaque pattern of holes with a surrounding transparent background surface, the fourth critical dimension comprising a range of critical dimensions being equal to or larger than the first critical dimension; and

(6) creating openings in the second layer of material in accordance with the third or fourth pattern of holes.

The above quoted and underlined and highlighted aspects of the claimed invention highlight the basic differences between the Peng invention and the claimed invention.

That is the Peng invention provides for a second mask that removes the compensating features.

The claimed invention provides for a second exposure uses the packing and unpacking concept of the claimed invention as

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

explained in detail in the specification of the claimed invention, most notably referring to Figs. 1a-1c, Figs. 2a-2c and the there-with supporting descriptions, which specifically refer to the type of exposure mask that is being used (the third pattern of holes being a transparent/opaque pattern of holes with a surrounding opaque background surface and the fourth pattern of holes being a transparent/opaque pattern of holes with a surrounding opaque background surface) in combination with the specifies patterns of exposure. The basic principles of these concepts have been explained in detail in the specification of the claimed invention, most notably in the descriptive text starting with the last paragraph on page 22 of the specification, to which Examiner is kindly referred.

The claimed invention provides:

- a method of creating contact holes of sub-micron dimensions whereby the provided method is not limited to holes of one hole-diameter to hole-distance ratio
- a method of creating contact holes which is not dependent on the density of the created images
- a method of creating contact holes which purposely packs the holes up in order to reduce the spread of pitches and to take

advantage of the improvement of off-axis illumination to closely packed and equally pitched features, making proximity effects effectively irrelevant to the invention.

By contrast, Peng provides for a method that assures equal sized features within an image that is created using photolithographic exposure masks, such as for instance isolated feature 9 of Fig. 2c of Peng having equal width as nested feature 11 of this figure.

The latter stated aspects of the claimed invention can be highlighted as follows:

1. the third and the fourth pattern of holes is aligned with the second pattern of holes, meaning that the method of the claimed invention of improved contact hole creation for ultra-small contact holes is provided in a uniform manner over the entire surface that is being exposed
2. the creation of the contact holes is further specified and claimed by the claimed invention as being performed using an exposure mask that, for the third and the fourth pattern of holes, comprises:
 - (i) a transparent pattern of holes with a surrounding opaque background surface, and

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

(ii) an opaque pattern of holes with a surrounding transparent background surface.

The above highlighted and underlined aspects of the claimed invention are neither provided for nor addressed by the Peng invention.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claim 1 under 35 U.S.C. 102(e) as being anticipated by Peng (U.S. Patent 6,514,648), be withdrawn.

Claim Rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claim 1 under 35 U.S.C. 102(e) as being anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent 6,337,175 (Yamaguchi) is respectfully requested based on the following.

Yamaguchi provides a method for forming resist pattern. More specifically, Yamaguchi provides for:

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

- performing a first exposure, creating a first pattern of photoresist over a substrate
- covering the first pattern with a denaturing agent, and
- performing a second exposure with a pattern that is rougher than the first pattern.

The method provided by Yamaguchi in particular addresses concerns arising in creating patterns that contain isolated patterns and further to improve dimensional accuracy of the process latitude in creating semiconductor devices, most notably gate electrode structures.

To achieve these objectives, Yamaguchi makes use of chemical interaction properties of the materials used for the creation of first and the second pattern, such as highlighted in col. 3, lines 27 e.a., for instance:

- according to a second aspect of the invention, the polymer comprises a substituent which is decomposed by the first given component
- according to the third aspect of the invention, in the resist pattern forming method, the first given component is a cross-linking component, and the denaturing agent comprises a first

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

component which generates an agent on the exposure and a second component forced to generate the cross-linking component by the agent.

Yamaguchi therefore does not provide for the essential aspects of the claimed invention, that is of providing packing and unpacking mask as have been explained in detail in the specification of the claimed invention and as can further be highlighted by quoting amended claim 1 of the claimed invention, which specifies the method of the claimed invention of creating closely spaced contact holes, underling in this quote the aspects of the claimed invention that relate to the packing and unpacking aspects of the claimed invention as follows:

(1) providing a substrate, said substrate having been provided with a first layer of material for creation of a pattern of contact holes;

(2) exposing said first layer of material with a first mask, said first mask comprising a first and a second pattern of contact holes;

(3) creating openings in said first layer of material in accordance with said first and second pattern of contact holes;

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

(4) depositing a second layer of material over said first layer of material, including said openings created in said first layer of material in accordance with said first and second pattern of holes;

(5) exposing said second layer of material with a mask selected from the group consisting of:

(i) a second mask comprising a third pattern of holes, said third pattern of holes **being aligned with said second pattern of holes**, said third pattern of holes being a transparent pattern of holes with a surrounding opaque background surface

(ii) a third mask comprising a third pattern of holes, said third pattern of holes **being aligned with said second pattern of holes**, said third pattern of holes being an opaque pattern of holes with a surrounding transparent background surface

(iii) a fourth mask comprising a fourth pattern of holes, said fourth pattern of holes **being aligned with said first pattern of holes**, said fourth pattern of holes being a transparent pattern of holes with a surrounding opaque background surface;

(iv) a fifth mask comprising a fourth pattern of holes, said fourth pattern of holes **being aligned with said first pattern of holes**, said fourth pattern of holes being an opaque

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

pattern of holes with a surrounding transparent background surface; and

(6) creating openings in said second layer of material in accordance with said third or fourth pattern of holes, holes of said third or fourth pattern of holes having a diameter being larger than a diameter of holes of said first and second pattern of holes by a measurable amount.

In short, Yamaguchi first and second exposes using the same pattern, the claimed invention uses pattern packing and unpacking masks, having related but different patterns, to compensate for optical exposure proximity effects.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claim 1 under 35 U.S.C. 102(e) as being anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent 6,337,175 (Yamaguchi), be withdrawn.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

Claim Rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claim 1 under 35 U.S.C. 102(b) as being anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent 5,424,154 (Borodovsky) is respectfully requested based on the following.

Borodovsky provides for an exposure enhancement method and apparatus, which specifically addresses concerns of a difference of optical exposure between periodic and randomly spaced patterns.

More specifically, see col. 3, lines 23 e.a., Borodovsky provides for, on a first exposure mask, the addition of complementary features to isolated device features. This is further demonstrated by Figs. 3-5, which show an (isolated) feature 301, surrounded by complementary features 310-313.

Borodovsky provides for, see col. 3, lines 30 e.a., isolated features having a dimension equal to or better than that achievable with periodic structures.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

The claimed invention, by contrast and as described in detail in the specification of the claimed invention:

- purposely packs up a pattern of desired holes in order to reduce the spread of pitches and to take advantage of the improvement of off-axis illumination to closely packed and equally pitched features
- proximity effects have to be corrected but are effectively irrelevant to the invention
- provides a first mask, referred to as the packed mask, comprising the desired contact holes
- to the packed mask are added padding holes in order to increase the hole density of the packed mask and to reduce the range of hole pitches
- a second mask, referred to as the unpacking mask, comprises openings at the same locations as the locations of the padding holes of the first mask, the openings provided in the second mask have slightly larger dimensions than the padding holes of the first mask
- a first exposure is made using the packed mask, a second exposure of the same surface area is made using the unpacking mask

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

- the unpacking mask is used to selectively cover the padding contact holes, resulting in the final image, whereby, see claim 1 of the claimed invention, "holes of said third or fourth pattern of holes having a diameter being larger than a diameter of holes of said first and second pattern of holes by a measurable amount".

The above aspects of the claimed invention, which are not provided by Borodovsky, can be demonstrated by quoting amended claim 1 of the claimed invention, which specifies the method of the claimed invention of creating closely spaced contact holes, underlining in this quote the aspects of the claimed invention that are not provided by Borodovsky, making the claimed invention patentable over the Borodovsky invention, as follows:

(1) providing a substrate, the substrate having been provided with a first layer of material for creation of a pattern of contact holes;

(2) exposing the first layer of material with a first mask, the first mask comprising a first and a second pattern of contact holes having a first and second critical dimension, the first and second pattern being interspersed;

(3) creating openings in the first layer of material in accordance with the first and second pattern of contact holes;

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

(4) depositing a second layer of material over the first layer of material, including the openings created in the first layer of material in accordance with the first and second pattern of holes;

(5) exposing the second layer of material with a mask selected from the group consisting of:

(i) a second mask comprising a third pattern of holes having a third critical dimension, the third pattern of holes being aligned with the second pattern of holes, the third pattern of holes being a transparent pattern of holes with a surrounding opaque background surface, the third critical dimension comprising a range of critical dimensions being equal to or larger than said second critical dimension;

(ii) a third mask comprising a third pattern of holes having a third critical dimension, the third pattern of holes being aligned with the second pattern of holes, the third pattern of holes being an opaque pattern of holes with a surrounding transparent background surface, the third critical dimension comprising a range of critical dimensions being equal to or larger than the second critical dimension;

(iii) a fourth mask comprising a fourth pattern of holes having a fourth critical dimension, the fourth pattern of holes being aligned with the first pattern of holes, the fourth

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

pattern of holes being a transparent pattern of holes with a surrounding opaque background surface, the fourth critical dimension comprising a range of critical dimensions being equal to or larger than the first critical dimension;

(iv) a fifth mask comprising a fourth pattern of holes having a fourth critical dimension, the fourth pattern of holes being aligned with the first pattern of holes, the fourth pattern of holes being an opaque pattern of holes with a surrounding transparent background surface, the fourth critical dimension comprising a range of critical dimensions being equal to or larger than the first critical dimension; and

(6) creating openings in the second layer of material in accordance with the third or fourth pattern of holes.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claim 1 under 35 U.S.C. 102(b) as being anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over U.S. Patent 5,424,154 (Borodovsky), be withdrawn.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

Claim Rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claims 2-19 under 35
U.S.C. 103(a) as being unpatentable over U.S. Patent 5,424,154

(Borodovsky) in view of U.S. Patent 6,514,648 (Peng) is
respectfully requested based on the following.

The relative merits of the (Borodovsky) in view of U.S.
Patent 6,514,648 (Peng) have been highlighted above and are
enclosed at this time by reference as being equally applicable
to claims 2-19 of the claimed invention.

Claims 2-19 are dependent claims to claim 1 and provide
required and important detail regarding the preferred
implementation of the claimed invention by one skilled in the
art. Without these specifications the implementation of the
claimed invention cannot be performed by one skilled in the art
in the preferred manner of the claimed invention in a preferred
and unambiguous manner. These claims are therefore required.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

Since these claims are dependent claims to independent claim 1, and since it has been argued above that independent claim 1 is patentable over Peng and Borodovsky, singly or in combination, it is respectfully submitted by Applicant that these dependent claims also cannot properly be rejected under 35 U.S.C. 103(a) as being patentable over Peng and Borodovsky, for reasons cited by the Examiner.

For instance, the preferred patterns for the first and second pattern of the claimed invention are patterns of contact holes, as specified in dependent claims 2 and 3. This must be specified in order to address one of the key objectives of the claimed invention, as stated in the first paragraph on page 1 of the specification of the claimed invention, as follows: "to a method of improved contact hole creation for ultra-small contact holes".

The second pattern of holes may however also be a pattern of dummy holes, as specified in dependent claim 4.

Dependent claims 4-7 specify the preferred method of the claimed invention for creating openings in the various layers of material, without these claims this important processing step

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

would not be clearly defined and would therefore be open to confusing interpretation.

Claims 8-11 specify the preferred materials of the claimed invention that are to be used for the creation of the various layers of material that are provided by the claimed invention, these specifications are also required since a large number of materials are used in the art. These claims 8-11 therefore limit this large number of available materials in the art to the preferred materials to be used for the provided layers of the claimed invention.

Claims 12 and 13 specify preferred treatment of the first layer of material in order to further improve performance of the end-results obtained by the claimed invention, this has been discussed in detail in the original specification of the claimed invention.

Claims 14-19 specify preferred characteristics of the hole patterns that are provided by the claimed invention. The patterns provided by the claimed invention are basic to a successful implementation of the claimed invention, it is

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

therefore of key importance to specify any preferred characteristics of these patterns, as these characteristics relate to for instance holes of the second pattern being created by adding one additional hole to each side of holes of said first pattern (claim 14), the one additional hole being separated from the each side of holes of said first pattern by an equal distance (claim 15), the equal distance being within a range of between one time and two times the size of a largest cross section of said first hole (claim 16), the one additional hole having a cross section of a size about equal to a cross section of holes of said first pattern (claim 17), overlapping holes of the second pattern of holes are combined into larger holes (claim 18) and the one additional hole added to each side of holes of said first pattern being eliminated where the one additional hole overlaps holes of the first pattern of holes (claim 19).

It is clear that without the claims 14-19, important and preferred aspects of the creation of for instance the first and second patterns that are provided by the claimed invention would not be clearly identified and clearly specified. These claims, in addition to the other dependent claims cited above, are

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

therefore required in order to allow one skilled in the art to implement the claimed invention in the preferred manner thereof.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 2-19 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,424,154 (Borodovsky) in view of U.S. Patent 6,514,648 (Peng), be withdrawn.

Claim Rejections - 35 U.S.C. § 103(a)

Reconsideration of the rejection of claims 26-61 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,424,154 (Borodovsky) in view of U.S. Patent 6,514,648 (Peng) is respectfully requested based on the following.

The relative merits of (Borodovsky) in view of U.S. Patent 6,514,648 (Peng) have been highlighted above and are enclosed at this time by reference as being equally applicable to claims 26-61 of the claimed invention.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

While Borodovsky may teach some elements of photolithographic exposure in commonality with the claimed invention, Borodovsky specifically does not provide for the aspects of the exposure mask of the claimed invention that are underlined following, using for this purpose a copy of amended claim 26, which specifies a packed mask of the claimed invention for creating closely spaced contact holes, whereby these aspects of the claimed invention as highlighted for independent claim 26 equally apply to the independent claims 35, 44 and 53 of the rejected claims 26-61, as follows:

a first mask comprising a first and a second pattern of contact holes, the first pattern of contact holes having a first critical dimension, the second pattern of contact holes having a second critical dimension, the first and second pattern being interspersed;

a second mask comprising a third pattern of holes, the third pattern of holes being aligned with the second pattern of holes, the third pattern of holes being a transparent pattern of holes with a surrounding opaque background surface, the third pattern of holes having a third critical dimension, the third critical dimension comprising a range of critical dimensions being equal to or larger than the second critical dimension.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

Peng and Borodovsky do not, contrary to Examiner's assertions, solve the same problems as addressed by the claimed invention, as is clear from the following aspects of the claimed invention, at variance with the Peng and Borodovsky inventions, as follows:

- the claimed invention provides a method of creating contact holes of sub-micron dimensions whereby the provided method is not limited to holes of one hole-diameter to hole-distance ratio
- the claimed invention provides a method of creating contact holes which is not dependent on the density of the created images
- the claimed invention provides a method of creating contact holes which purposely packs the holes up in order to reduce the spread of pitches and to take advantage of the improvement of off-axis illumination to closely packed and equally pitched features, **making proximity effects effectively irrelevant to the claimed invention.**

These latter aspects of the claimed invention are clear from and are further emphasized by the above quoted claim 26 of the claimed invention.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 26-61 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,424,154 (Borodovsky) in view of U.S. Patent 6,514,648 (Peng), be withdrawn.

Claim Rejections - 35 U.S.C. § 103(a)

Reconsideration of the rejection of claims 20-25 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,424,154 (Borodovsky) in view of U.S. Patent 6,277,543 (Furukawa et al.) is respectfully requested based on the following.

The relative merits of Borodovsky have been highlighted above and are enclosed at this time by reference as being equally applicable to claims 20-25 of the claimed invention.

While Furukawa et al. may teach some aspects of the claimed invention in commonality with the claimed invention, such as the use of dual tone resist, Furukawa et al. do not address nor provide for the essential aspects of the claimed invention, as is shown following by quoting amended claim 20 of the claimed

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

invention, which specifies the method of the claimed invention of creating closely spaced contact holes, underlining in this quote the aspects of the claimed invention that are not provided by Furukawa et al., as follows:

- providing a substrate, the substrate having been provided with a layer of dual-polarity resist for creation of a pattern of contact holes
- exposing the layer of dual-polarity resist with a mask, the mask comprising a first and a second pattern of contact holes, creating a first and a second pattern of exposure in the layer of dual-polarity resist, the first and second pattern of contact holes having a first and second critical dimension, the first and second pattern of contact holes being interspersed
- selectively exposing the layer of dual-polarity resist to a source of radiation, the selective exposure being in accordance with the second pattern of exposure in the layer of dual-polarity resist, thereby inhibiting creating openings in the layer of dual-polarity resist in accordance with the second pattern of exposure, the selective exposure comprising a range of critical dimensions being equal to or larger than the first critical dimension, and

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

- developing the layer of dual-polarity resist in accordance with the first pattern of exposure.

The potential commonality of the use of a dual tone resist between the claimed invention and the Furukawa et al. invention cannot reasonably be used as an argument for asserting that the claimed invention can readily be derived from the Furukawa et al. invention. Different inventions may well have one or more processing parameters or materials used and the like in common whereby however these processing parameters and materials are most likely used in unique methods for each of the different inventions, making these different inventions patentable in their own right. It is respectfully submitted by Applicant that such is the case with regards to the potential commonality in use of a patterning material between the Furukawa et al. invention and the claimed invention.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 20-25 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,424,154

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

(Borodovsky) in view of U.S. Patent 6,277,543 (Furukawa et al.),
be withdrawn.

Claim Rejections - 35 U.S.C. § 103(a)

Reconsideration of the rejection of claims 2-19 under 35
U.S.C. 103(a) as being unpatentable over Peng (U.S. Patent
6,514,648) in view of U.S. Patent 5,424,154 (Borodovsky) is
respectfully requested based on the following.

The relative merits of Peng and Borodovsky and with respect
to the claimed invention have been discussed above and are
enclosed at this time by reference as being equally applicable
to claims 2-19 of the claimed invention.

Claims 2-19 specify important and required detail as these
detail relate to the preferred implementation of the claimed
invention.

For instance, the preferred patterns for the first and
second pattern of the claimed invention are patterns of contact
holes, as specified in dependent claims 2 and 3. This must be

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

specified in order to address one of the key objectives of the claimed invention, as stated in the first paragraph on page 1 of the specification of the claimed invention, as follows: "to a method of improved contact hole creation for ultra-small contact holes".

The second pattern of holes may however also be a pattern of dummy holes, as specified in dependent claim 4.

Dependent claims 4-7 specify the preferred method of the claimed invention for creating openings in the various layers of material, without these claims this important processing step would not be clearly defined and would therefore be open to confusing interpretation.

Claims 8-11 specify the preferred materials of the claimed invention that are to be used for the creation of the various layers of material that are provided by the claimed invention, these specifications are also required since a large number of materials are used in the art. These claims 8-11 therefore limit this large number of available materials in the art to the preferred materials to be used for the provided layers of the claimed invention.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

Claims 12 and 13 specify preferred treatment of the first layer of material in order to further improve performance of the end-results obtained by the claimed invention, this has been discussed in detail in the original specification of the claimed invention.

Claims 14-19 specify preferred characteristics of the hole patterns that are provided by the claimed invention. The patterns provided by the claimed invention are basic to a successful implementation of the claimed invention, it is therefore of key importance to specify any preferred characteristics of these patterns, as these characteristics relate to for instance holes of the second pattern being created by adding one additional hole to each side of holes of said first pattern (claim 14), the one additional hole being separated from the each side of holes of said first pattern by an equal distance (claim 15), the equal distance being within a range of between one time and two times the size of a largest cross section of said first hole (claim 16), the one additional hole having a cross section of a size about equal to a cross section of holes of said first pattern (claim 17), overlapping holes of the second pattern of holes are combined into larger

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

holes (claim 18) and the one additional hole added to each side of holes of said first pattern being eliminated where the one additional hole overlaps holes of the first pattern of holes (claim 19).

It is clear that without the claims 14-19, important and preferred aspects of the creation of for instance the first and second patterns that are provided by the claimed invention would not be clearly identified and clearly specified. These claims, in addition to the other dependent claims 2-13 cited above, are therefore required in order to allow one skilled in the art to implement the claimed invention in the preferred manner thereof.

Where Peng discusses the application of positive and negative tone resists and the use of masks associated therewith, Peng provides this discussion as part of the Background of the Invention description and does thereafter make no further use of these specific materials or their specific characteristics.

This as opposed to the claimed invention which provides alternative methods and procedures that do make very specific

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

use of the characteristics of positive and negative tone resists, as specified in for instance independent claim 1 to which claims 2-19 are dependent claims, as follows and quoting from amended claim 1 of the claimed invention:

the third pattern of holes being a transparent pattern of holes with a surrounding opaque background surface

the third pattern of holes being an opaque pattern of holes with a surrounding transparent background surface

the fourth pattern of holes being a transparent pattern of holes with a surrounding opaque background surface, and

the fourth pattern of holes being an opaque pattern of holes with a surrounding transparent background surface.

Borodovsky does not, as best as can be determined and contrary to Examiner's assertions, discuss or provide for or make any special use of differentiating between positive and negative tone resists.

While applicant acknowledges the teachings of Peng and Borodovsky as cited by the Examiner, and although applicant does not necessarily agree that the Examiner's arguments show sufficient and proper basis for suggestion or motivation to

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

modify or combine Peng with Borodovsky, applicant nonetheless also asserts that there is absent within the portions of Peng and Borodovsky or any combination thereof, as cited by the Examiner, an express or inherent teaching of each and every limitation within applicant's invention as taught and claimed within claims 2-19.

In this regard, applicant claims that there is absent from the portions of Peng and Borodovsky, or any combination thereof, as cited by Examiner, a teaching of exposing a first layer of material with a first mask, the first mask comprising a first and a second pattern of contact holes having a first and second critical dimension, the first and second pattern being randomly interspersed, of creating openings in the first layer of material in accordance with the first and second pattern of contact holes, of depositing a second layer of material over the first layer of material, of exposing the second layer of material with a mask selected from the group consisting of a second mask comprising a third or fourth pattern of holes having critical dimensions being larger than the critical dimensions of first or second critical dimensions, the third or fourth pattern being more dense than the first or second pattern.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

None of the applied or known references address the invention as shown in the amended claims in which a method is provided of creating contact holes of sub-micron dimensions whereby the provided method is not limited to holes of one hole-diameter to hole-distance ratio, of providing a method of creating contact holes which is not dependent on the density of the created images, and of providing a method of creating contact holes which purposely packs the holes up in order to reduce the spread of pitches and to take advantage of the improvement of off-axis illumination to closely packed and equally pitched features, making proximity effects effectively irrelevant to the invention.

The invention is believed to be patentable over the prior art cited, as it is respectfully suggested that the combination of these various references cannot be made without reference to Applicant's own invention.

None of the applied references address the problem of providing a method of creating contact holes of sub-micron dimensions whereby:

- the provided method is not limited to holes of one hole-diameter to hole-distance ratio

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

- the range of the ratio of hole-diameter to hole-distance is narrowed to an optimum range of off-axis illumination
- using a packing and unpacking procedure
- resulting in improved Depth Of Focus (DOF) during the creation of contact holes, and
- resulting in an improved Mask Error Factor (MEF) associated with the creation of contact holes.

Applicant has claimed the process in detail. The processes of Figs. 1a-7c are both believed to be novel and patentable over these various references, because there is not sufficient basis for concluding that the combination of claimed elements would have been obvious to one skilled in the art. That is to say, there must be something in the prior art or line of reasoning to suggest that the combination of these various references is desirable.

We believe that there is no such basis for the combination. We therefore request Examiner Kripa Sagar to reconsider the rejection in view of these arguments and the amendments to the Claims.

Appl. No : 10/002,986
Amdt. dated : 07/05/04
Reply to Office Action of 01/07/04

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 2-19 under 35 U.S.C. 103(a) as being unpatentable over Peng (U.S. Patent 6,514,648) in view of U.S. Patent 5,424,154 (Borodovsky), be withdrawn.

Other Considerations

New dependent claims 62-69 have been written as a result of this office action.

It is requested that, should Examiner not find the claims to be allowable, to call the undersigned Attorney at the Examiner's convenience at 845-452-5863 in order to overcome any problems preventing allowance of the claims.

Respectfully submitted,



Stephen B. Ackerman
Reg. No 37,761
Tel. (845) 452-5863